

AD-A033 918

DEFENSE SYSTEMS MANAGEMENT SCHOOL FORT BELVOIR VA
NEW RADAR FOR THE F-13 - A DISCOUNTED CASH FLOW ANALYSIS.(U)
MAY 76 P W VENN

F/G 5/3

UNCLASSIFIED

NL

1 of 1
ADA033918



ADA 033918

DEFENSE SYSTEMS^{nu} MANAGEMENT SCHOOL



PROGRAM MANAGEMENT COURSE INDIVIDUAL STUDY PROGRAM

6	NEW RADAR FOR THE F-13 - A DISCOUNTED CASH FLOW ANALYSIS.
9	STUDY PROJECT REPORT. PMC 76-1
10	Porter W. Venn LTCOL USAF
11	May 76
12	27p.

FORT BELVOIR, VIRGINIA 22060

DDC
RECEIVED
JAN 4 1977
A

RTS	White Section	<input checked="" type="checkbox"/>
DR	Red Section	<input type="checkbox"/>
UNANNOUNCED		<input type="checkbox"/>
JUSTIFICATION		
DISTRIBUTION/AVAILABILITY CODES		
Dist.	Small	Large/SPECIAL
A		

408 462

lpg

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) NEW RADAR FOR THE f-13 A DISCOUNTED CASH FLOW ANALYSIS	5. TYPE OF REPORT & PERIOD COVERED Study Project Report	
7. AUTHOR(s) Porter W. Venn	6. PERFORMING ORG. REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060	8. CONTRACT OR GRANT NUMBER(s)	
11. CONTROLLING OFFICE NAME AND ADDRESS DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	12. REPORT DATE 76-1	
	13. NUMBER OF PAGES 24	
	15. SECURITY CLASS. (of this report) UNCLASSIFIED	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report) UNLIMITED		
<div style="border: 1px solid black; padding: 5px; display: inline-block;"> DISTRIBUTION STATEMENT A Approved for public release; Distribution Unlimited </div>		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) SEE ATTACHED SHEET		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) SEE ATTACHED SHEET		

STUDY TITLE:

New Radar for the F-13 - A Discounted Cash Flow Analysis

STUDY PROJECT GOALS: To demonstrate the application of economic analysis to government acquisition alternatives and discounted cash flow techniques to the determination of optimal production methods, through the use of a case study to be used as a teaching device in a corporate and/or government finance course.

STUDY REPORT ABSTRACT:

The case study is presented in four parts:

Part A is the application of economic analysis in determining the optimal acquisition strategy for a new radar to be installed in an existing fighter aircraft. Alternatives include modification of an existing radar and development of a new state of the art radar.

Part B is the introduction of a discrete probability distribution of the previous analysis. Cash flows are now based on expected value.

Part C is the use of discounted cash flow techniques in determining the optimal among three possible alternative production methods for the above radar. The alternatives include subcontracting, modification of an existing production line, and procurement of a new, fully automated production line.

Part D is the introduction of a variation in volume and its impact on the previous decision.

Included with the case is a section of instructor's notes and suggested student analysis.

KEY WORDS: Economic Analysis, Discounted Cash Flow.

RESOURCES	MANAGEMENT	FINANCIAL MANAGEMENT	DISCOUNTING
MATERIEL	ACQUISITION	LIFE CYCLE COST	DECISION THEORY
ECONOMIC ANALYSIS			
BUDGETS			

NAME, RANK, SERVICE	CLASS	DATE
Porter W. Venn, LtCol, USAF	PMC 76-1	May 1976

NEW RADAR FOR THE F-13
A DISCOUNTED CASH FLOW ANALYSIS

Study Project Report
Individual Study Program

Defense Systems Management School
Program Management Course
Class 76-1

by
Porter W. Venn
LTCOL USAF

May 1976

Study Project Advisor
Dr. Benjamin C. Rush

This study project report represents the views, conclusions and recommendations of the author and does not necessarily reflect the official opinion of the Defense Systems Management School or the Department of Defense.

EXECUTIVE SUMMARY

This report is a case study on the application of economic analysis and discounted cash flow techniques as an input to the decision making process regarding the acquisition of major weapon systems.

The case contains four separate parts, which include:

A. Application of economic analysis in the selection of the best of two alternative acquisition strategies for the installation of a new radar on a fighter aircraft already in the operational inventory - modification of an existing radar presently being installed on another aircraft or development of an advanced state of the art radar.

B. Introduction of uncertainty and its impact on the acquisition decision. Several of the applicable cash flows are converted from a point estimate to a discrete probability distribution and the expected value of cash flows must be determined.

C. Application of discounted cash flow analysis to three alternative production methods envisioned by a prospective manufacturer of the radar. The alternatives include subcontracting, modification of an existing production line, and purchase of a fully automated production line.

D. Introduction of increased volume and its impact on the selection of the best production methodology.

The case is designed for use as a teaching device in a corporate and/or government finance course. It includes instructor's notes and suggested student analysis.

TABLE OF CONTENTS

EXECUTIVE SUMMARY.	ii
SECTION	
I. CASE STUDY	1
A. ECONOMIC ANALYSIS.	1
B. UNCERTAINTY	5
C. CHOOSING PRODUCTION METHODOLOGY.	7
D. IMPACT OF INCREASED VOLUME	10
II. INSTRUCTOR NOTES	12
III. STUDENT ANALYSIS	15
APPENDIX A. Table - Present Value of \$1.. . . .	19
APPENDIX B. Table - Present Value of \$1.. . . .	20
Received annually for N years.	
BIBLIOGRAPHY	21

NEW RADAR FOR THE F-13
A DISCOUNTED CASH FLOW ANALYSIS

A.
ECONOMIC ANALYSIS

You are a systems engineer in the F-13 Chicken Hawk program office. You are involved in the preparation of a systems specification involving the incorporation of all-weather radar capability into the Chicken Hawk.

The present Chicken Hawk, which has been in the operational inventory for 5 years, is a twin engine, mach 2.5, air superiority fighter, with a limited capability conical scan radar. It is armed with the AIM-27 Zinger missile, with infra-red homing and 5 mile range capability. Initial acquisition cost for the aircraft was \$5 million and it has an estimated remaining service life of 15 years. It is equipped with an inertial navigation system and a 4000 word memory computer for displaying fire control solutions on the heads-up display. There are presently 800 Chicken Hawks in the operational inventory.

The systems specification that you are writing will require significant aircraft modification and will include a pulse doppler radar, display, 32,000 word memory computer, and lookdown capability. The modification will utilize components from the present inertial navigation system and heads-up display. The aircraft will be armed with the new AIM-41 Zonker missile with Shootdown radar homing and 40 mile range capability.

After doing extensive analysis and tradeoffs between all conceivable options, you have managed to narrow the field to two possible alternative acquisition strategies:

Alternative 1: Buy an existing radar presently being supplied for another fighter on a firm fixed price contract by Little Dandy All-Purpose Radar Supply Corp. This radar can meet the requirements, but will require extensive modification to increase power and antenna size. A development effort will be required. The aircraft nose must be modified to incorporate the larger antenna and extensive rewiring and component relocation will be required. The radar will include a simple raster-scan display. Anticipated procurement is 1000 units (800 aircraft + 25% spares). Estimated costs are:

<u>Item</u>	<u>Years</u>	<u>Cost (Mill.)</u>
Development Effort.	1	\$ 20.
Radar (1000 units @ \$200,000)	2&3	200.
Radar modification (1000 units @ 200,000)	2&3	200.
Aircraft modification (800 units @ \$100,000)	2&3	80.
Total		<u>\$500.</u>

It is estimated that radar acquisition, modification, and installation costs will be incurred fairly evenly over years 2&3.

Alternative 2: Buy an advanced state-of-the-art radar presently in the conceptual development stage. This radar will also meet the requirements, but will incorporate new technology, including micro-miniaturized, large scale integrated circuitry, parametric amplifiers, an improved traveling wave tube, and a stroke-written display. The aircraft will not require structural modification but will still require rewiring and component relocation. A three year engineering development effort will also be required. Biggie Consolidated Aircraft Incorporated and two competitors have facilities that could handle a production effort of this nature. Estimated costs are:

<u>Item</u>	<u>Years</u>	<u>Cost (Mill.)</u>
Engineering Development.	1-3	\$300.
Radar (1000 units @ \$260,000).	4-5	260.
Aircraft rewire (800 units @ \$50,000).	4-5	40.
Total		<u>\$600.</u>

It is anticipated that all costs will be incurred fairly evenly over the applicable years.

It is Friday morning. You have completed your analysis and are ready to present the results to the Chicken Hawk program manager. You are pleased with the outcome of your efforts and are convinced that the depth of your analysis will persuade your PM to go with Alternative 1, since Alternative 2 costs 20% more and has greater technical risk.

Your secretary informs you that one Doctor Benardo Tush is on the phone from the Pentagon. After 2 minutes on the phone with Doctor Tush, you have lost a great deal of your confidence. He informs you that in addition to his position in the OSD Comptroller office, he is a member of the Cost Analysis Improvement Group (CAIG) which will certainly review the cost implications of your acquisition plan, the rough details of which he is already aware. He stated that he is confident that you are a highly capable young systems analyst and will therefore be well prepared to present the economic analysis that you have prepared (in accordance with DODI 7041.3) to the CAIG at the appropriate time. He also informs you that the CAIG will be highly interested in your in-depth analysis of life cycle costs. You assure Doctor Tush that you have all of these aspects under control.

Now that this winner from OSD has ruined your whole day, you have to decide what to do next. After some soul searching, you inform your PM that your analysis will take a few more days. During that time you gather the following data regarding the life cycle cost implications of the previous alternatives:

Alternative 1:

<u>Item</u>	<u>Years</u>	<u>Cost (Mill.)</u>
Peculiar Support Equipment (1 Unit/20. . . . 3 aircraft = 40 @ \$500,000)	3	\$20.
Initial training, data, etc. 3	3	30.
Operation & Support costs (MTBF=100 hours) . 4-15	4-15	20.

Alternative 2:

<u>Item</u>	<u>Years</u>	<u>Cost (Mill.)</u>
Peculiar Support Equipment (Uses multi- purpose test equipment.		0
Initial training, data, etc 5	5	\$40.
Operation & Support Costs (MTBF= 200 hours) 6-15	6-15	10.

- A. What is the appropriate discount rate to use in performing the economic analysis?
- B. Based on the results of your economic analysis, what is the optimal alternative?

(Assume that cash flows occur at the end of the applicable years. Also assume that the benefits from the 2 year earlier delivery of Alternative 1 are just offset by the increased capability of Alternative 2).

B.

UNCERTAINTY

Several days have gone by. Your analysis now includes life cycle cost implications, you have performed an economic analysis in accordance with DODI 7041.3, and you are once again prepared to brief the Chicken Hawk program manager, now that you are a little older and hopefully a little wiser.

Your secretary informs you that one Doctor Donte Herzog is on the phone from the Pentagon. Doctor Herzog informs you that he works in the office of OSD Program Analysis and Evaluation (PA&E) and in addition is a member of the Cost Analysis Improvement Group (CAIG). His associate Doctor Tush has informed him of the high quality of your work and he is therefore confident (99%) that you have had the foresight to consider uncertainty in the performance of your analysis. As the conversation ends, he informs you as to how delighted he will be to explore your analysis of uncertainty when you make your presentation to the CAIG. Now that you have received this second piece of bad news from OSD, you make another value judgement. You inform your PM that your analysis will take a few more days and after some effort are able to persuade him that you are still engaged in a serious endeavor. During that time you gather estimates as to uncertainty from the best authorities to whom you can obtain immediate access. (In the Avionics Lab. and the Logistics Planning Division.) They are unable to provide any further information beyond the point estimates presented in Part A, except in the following areas:

	<u>Cost (Mill.)</u>	<u>Probability</u>
Engineering Development (Alternative 2)	\$300.	30%
	350.	30%
	400.	20%
	425.	20%
		<u>100%</u>
Operation & Support Costs (Alternative 1)	\$15.	10%
	20.	40%
	25.	30%
	30.	20%
		<u>100%</u>
Operation & Support Costs (Alternative 2)	\$ 5.	10%
	8.	20%
	10.	40%
	15.	20%
	20.	<u>10%</u>
		<u>100%</u>

A. How does this additional information affect your decision from Part A?

B. What is your next step? (multiple choice)

1. Present results to PM.
2. Ask OSD for further guidance.
3. Have phone disconnected.
4. Panic
5. Transfer
6. Retire
7. Other

C.

CHOOSING PRODUCTION METHODOLOGY

You are a production engineer in the employ of the Biggie Consolidated Aircraft Corporation. Management believes that it is highly probable that Biggie will be awarded the Chicken Hawk radar contract presently going through the government source selection process. Management also fervently believes that Biggie's long established reputation for technical excellence, for meeting cost and schedule targets, and for displaying dynamic management practices will be just adequate to overcome an obvious disadvantage - government representatives have to buy their own lunch in the company automat.

You have been assigned the task of developing a production plan for the Chicken Hawk radar. Biggie will have to provide the radars at a production rate of 500/year (contract completion in two years), but with follow-on sales for the Chicken Hawk, other military programs, and foreign military sales, it is anticipated that there will be a market for at least 5000-8000 radars over a ten year span. Management has asked you to consider three alternatives in your analysis:

Alternative 1: Subcontract - All production will be subcontracted to three vendors, with Biggie performing acceptance, inspection, and component integration tasks. Anticipated cash flows are as follows:

<u>Item</u>	<u>Years</u>	<u>Cost (Mill.)</u>
Sales (500 @ \$250,000)	1-10	(\$125.)
Subcontracts (500 @ \$150,000)	1-10	75.
Acceptance, Inspection, and Integration	1-10	42.
Specialized facility for radar component integration	0	25.

Depreciation - straight line, no salvage. Tax rate - 40%.

Alternative 2 - Modify existing production line

Biggie is presently phasing out a radar used in commercial applications, which will free up a production line for use on the Chicken Hawk radar production. However, the production line would require significant redesign to accommodate the new program, primarily on the drive mechanisms, access trays, and overhead racks. The labor would involve hand soldering, hand electronic component insertion, and manual test and checkout equipment. In addition, an updated production system must be designed, including work flow production drawings. Anticipated cash flows are as follows:

<u>Item</u>	<u>Years</u>	<u>Cost (Mill.)</u>
Sales (500 @ \$250,000)	1-10	(\$125.)
Production Labor (500 @ \$125,000)	1-10	62.5
Materials (500 @ \$25,000)	1-10	12.5
Overhead (production line)	1-10	20.0
Modifications to production line	0	35.0
Salvage value	10	(5.0)

Depreciation - straight line. Tax rate - 40%.

Alternative 3 - Fully automated production line

Biggie can also invest in new technology (for a significantly greater investment cost). This production line, which would be purchased as an entire unit, would incorporate the latest electronic equipment production technology, including automatic component insertion, automatic lead trimming, flow soldering, and computerized checkout equipment with tape print out indicating fault isolation. Fabrication of some mechanical components would be accomplished with automatic assembly equipment using pneumatic driven attachment mechanisms. Anticipated cash flows are as follows:

<u>Item</u>	<u>Years</u>	<u>Cost (Mill.)</u>
Sales (500 @ \$250,000)	1-10	(\$125.)
Production Labor (500 @ \$60,000)	1-10	30.
Materials (500 @ \$20,000)	1-10	10.
Overhead (production line)	1-10	25.
Initial investment	0	132.
Salvage	10	(10.)

Depreciation - straight line. Tax rate - 40%.

Biggie's weighted average cost of capital (WACC) is 20%, which they also use as their hurdle rate for capital investment decisions. Assume that cash flows occur at the end of the applicable years.

- A. Assuming that you use discounted present value as your decision criterion, which alternative would you choose?
- B. What is the internal rate of return (IRR) for alternative 1?

D.

IMPACT OF INCREASED VOLUME

You have briefed corporate management on your analysis and have received 5 "At-a-boy's." The next day, Biggie is informed by its Washington representative that the State Department has just received a request from the Sheik of Araby to purchase 1000 units of the new radar over the next ten (100/year) through foreign military sales channels. The radar will be used on the Sheik's fleet of brand new, Mach 4, F-29 Miracle fighters, presently standing five minute alert to guard against the ever-present danger of a surprise saturation bombing attack on the Oofi oasis by a certain unfriendly country, whose nearest border is 3000 miles away. You are asked to revise your analysis based on the possibility of the increased sales of 100 units/year for ten years. Alternative 3 is the only alternative that can handle the increased volume. Revised cash flows for alternative 3 are as follows:

<u>Item</u>	<u>Years</u>	<u>Cost (Mill.)</u>
Sales (600 @ \$250,000).	1-10	(\$150.)
Production Labor (600 @ \$60,000).	1-10	36.
Materials (600 @ \$20,000)	1-10	12.
Overhead (production line).	1-10	28.
Initial investment (minor modification. . .		
required to handle increased volume). . .	0	140.
Salvage	10	(10.)

Depreciation - Straight line. Tax rate - 40%.

A. What impact do the anticipated foreign military sales have on your previous decision as to the best alternative?

B. Biggie has just been informed that the Chicken Hawk radar contract has been awarded to the Little Dandy All-Purpose Radar Supply Corp. A prime criterion in the source selection was a new provision in the Armed Services Procurement Regulation (ASPR) entitled: "Give the little guy a break."

Corporate management has taken back your 5 "At-a-boy's." What would you recommend as the next step in your decision process?

INSTRUCTOR'S NOTES

Substantive Issues Raised:

The case presents the application of the traditional capital budgeting, discounted cash flow techniques in the determination of the optimal acquisition strategy for radar modification to an existing aircraft weapons system. The discount rate used is 10%, as specified by DODI 7041.3. The case proceeds to an analysis of uncertainty in the costs of the new radar development and follow on operation and support costs. The scene then switches to a potential contractor who must determine the optimal production methodology for the anticipated radar program. Once again, discounted cash flow techniques are utilized, this time with the introduction of depreciation and tax effects. Finally, the impact of volume variation on the selection of the optimal alternative is determined.

The case is broken into four parts, which can be assigned separately. However, Part B requires reference to Part A, and Part D requires reference to Part C.

The problem description and substantive issues of each part are:

Part A. Application of economic analysis (discounted cash flows) as a decision criterion in choosing between two acquisition alternatives. Alternative 1 is the modification of an existing radar presently being supplied for another aircraft. Alternative 2 is a development effort and procurement of a new radar. R&D and procurement costs are considered first, with subsequent introduction of life cycle costs. Undiscounted costs favor alternative 1, but when Operation & Support costs are introduced and all costs are discounted, alternative 2 becomes the least cost alternative. Other issues for discussion include:

1. Justification for a discount rate of 10% (specified by DODI 7041.3) and support for alternative rates. Based on a hypothetical cost of capital to the federal government.

2. The impact of the two year spread in development between alternatives 1 and 2, and the impact of increased capability of alternative 2. Factors external to straight numerical analysis.

3. Questions external to the economic analysis itself, such as the validity of presented costs and relationships. Other assumptions that could be made, differing from those presented in the case.

Part B. Application of uncertainty to the analysis from Part A. The development costs for alternative 2 and the O&S costs for both alternatives are switched from point estimates to discrete probability distributions, requiring the student to determine expected values for the three costs. The heavy loading of probability on the high cost side for development of alternative 2 causes the optimal alternative to switch to alternative 1. Other issues for discussion include:

1. Uncertainties other than those presented in the case.
2. Application of continuous probability distributions to various costs, which was considered to be outside the scope of the learning goals of this case.

Part C. Application of discounted cash flow techniques in the determination of an optimal production methodology by a selection among three alternatives. Alternative 1 is to subcontract the fabrication work, with the company retaining integration tasks. Alternative 2 involves the modification of an existing production line and utilization of manual assembly techniques. Alternative 3 involves the acquisition of a fully automated

production line. The impact of tax shield from depreciation is introduced. Alternative 1 results in a negative cash flow on a discounted basis and alternative 2 is superior to alternative 3 when discounted cash flows are the prime decision criterion. As an additional exercise, the student is asked to compute the internal rate of return (I.R.R.) for alternative 1.

Other issues for discussion include:

1. The proper "rate" - Cost of capital rate, hurdle rate, I.R.R. of other alternatives, or other?
2. The impact of depreciation methods other than straight line, which were not included in this case.
3. Determination of I.R.R. when cash flows are not even over the applicable years. Looking up values in discount tables on an iterative basis.
4. Factors external to cash flow analysis, such as impact of increased automation on labor, material, and overhead costs.

Part D. Impact of increased volume. Alternative 3 from part C is impacted by increased volume. It is assumed that alternatives 1 and 2 are not amenable to increased volume. This impact causes the optimal alternative to switch from #2 to #3. Other issues for discussion include:

1. Impact of limited capacity. The company might choose both alternatives 2 and 3, with sufficient capacity, thereby increasing volume, if relevant net cash flows remained positive.
2. Impact of increased volume on a low fixed investment - high variable cost production methodology as opposed to the impact on a high fixed cost - low variable cost production methodology.

STUDENT ANALYSIS

Part A:

<u>Alternative 1:</u>	<u>Cost</u>	<u>Years</u>	<u>Factor</u>	<u>Disc. Cost</u>
Development	\$ 20	1	.909	\$ 18.18
Radar, radar mod., A/C mods. (1/2)	240	2-3	1.577	378.48
P.S.E., training, data, etc.	50	3	.751	37.55
O&S costs	20	4-15	5.119	102.38
Total				<u>\$536.59 (mil.)</u>

(Students were given the assumption that production costs were incurred evenly over years 2 & 3, so they are split between years 2 & 3).

<u>Alternative 2:</u>	<u>Cost</u>	<u>Years</u>	<u>Factor</u>	<u>Disc. Cost</u>
Development (1/3)	\$100	1-3	2.487	\$248.70
Radar & A.C. rewire (1/2)	150	4-5	1.304	195.60
Training, etc.	40	5	.621	24.84
O&S Costs	10	6-15	3.815	38.15
Total				<u>\$507.29 (mil.)</u>

This is the optimal alternative on a discounted cash flow basis.
(Same note as under alternative 1)

Part B:

Alternative 1: Expected value, O & S costs:

	<u>Cost</u>	<u>p(cost)</u>	<u>Cost weight</u>
	\$15	.1	\$1.5
	20	.4	8.0
	25	.3	7.5
	30	<u>.2</u>	<u>6.0</u>
Expected value		<u>1.0</u>	<u>23.0</u>

	<u>Cost</u>	<u>Years</u>	<u>Factor</u>	<u>Disc. Costs</u>
O & S Costs	\$23	4-15	5.119	\$117.74
Other costs (no change)	-	-	-	<u>434.21</u>
Total				<u>\$551.95</u>

Alternative 2:

Expected value, development costs:

<u>Cost</u>	<u>p(Cost)</u>	<u>Cost Weight</u>
\$300	.3	\$ 90.
350	.3	105.
400	.2	80.
425	.2	85.
Expected Value	1.0	<u>\$360.</u>

Expected value, O & S costs:

<u>Cost</u>	<u>p(Cost)</u>	<u>Cost Weight</u>
\$ 5	.1	\$.5
8	.2	1.6
10	.4	4.0
15	.2	3.0
20	.1	2.0
Expected Value	1.0	<u>\$11.1</u>

	<u>Cost</u>	<u>Years</u>	<u>Factor</u>	<u>Disc. Cost</u>
Development (1/3)	\$120	1-3	2.487	\$298.44
O & S Costs	11.1	6-15	3.815	42.35
Other costs (no change)	-	-	-	<u>220.44</u>
Total				<u>\$561.23</u>

The optimal alternative switches to #1.

Part C:Alternative 1:

	<u>Rev (Cost)</u>	<u>Years</u>	<u>Factor</u>	<u>Disc. rev (Cost)</u>
Facility	(\$25.00)	0	1.0	(\$25.00)
Gross (Sales less cost)	8.0	1-10	4.192	33.54
Tax (40%)	(3.2)	1-10	4.192	(13.41)
Depreciation - Tax Shield (.4 x (25/10))	1.0	1-10	4.192	<u>4.19</u>
Total				<u>(.68)</u>

Negative cash flow!

<u>Alternative 2:</u>	<u>Rev(Cost)</u>	<u>Years</u>	<u>Factor</u>	<u>Disc.rev(Cost)</u>
Modifications	(35.0)	0	1.0	(\$ 35.00)
Gross (Sales less cost)	30.0	1-10	4.192	125.76
tax (40%)	(12.0)	1-10	4.192	(50.30)
Depreciation-Tax shield (.4 x (35-5)/10)	1.2	1-10	4.192	5.03
Salvage	5.0	10	.162	.81
Total				<u>\$46.30</u>

<u>Alternative 3:</u>	<u>Rev(Cost)</u>	<u>Years</u>	<u>Factor</u>	<u>Disc.rev(Cost)</u>
Investment	(\$132.00)	0	1.0	(\$132.00)
Gross (Sales less cost)	60.00	1-10	4.192	251.52
Tax (40%)	(24.00)	1-10	4.192	(100.61)
Depreciation - Tax shield (.4 x (132-10)/10)	4.88	1-10	4.192	20.46
Salvage	10.00	10	.162	1.62
Total				<u>\$40.99</u>

Optimal alternative on discounted cash flow basis is #2.

Determination of I.R.R. (Alternative 1):

Yearly cash flows:	Gross	\$8.0
	Tax shield	1.0
	Tax	(3.2)
Total		<u>\$5.8</u>

Investment (year 0) = $25.0 \div 5.8 = 4.31$.

Present value of annuity table, 10 years, at 4.31:
Rate \approx 19%

Part D:

Alternative 3: (No change in 1 or 2)

	<u>Rev(Cost)</u>	<u>Years</u>	<u>Factor</u>	<u>Disc.rev(Cost)</u>
Investment	(\$140.0)	0	1.0	(\$140.00)
Gross (sales less cost)	74.0	1-10	4.192	310.21
Tax (40%)	(29.6)	1-10	4.192	(124.08)
Depreciation - Tax shield (.4 x (140-10)/10)	5.2	1-10	4.192	21.80
Salvage	10.0	10	.162	<u>1.62</u>
Total				<u>\$69.55</u>

Optimal alternative switches to #3.

APPENDIX A

Table A
PRESENT VALUE OF \$1

Years Hence	1%	2%	4%	6%	8%	10%	12%	14%	15%	16%	18%	20%	22%	24%	25%	26%	28%	30%	35%	40%	45%	50%
1	0.990	0.980	0.961	0.943	0.925	0.909	0.893	0.877	0.870	0.862	0.847	0.833	0.820	0.806	0.800	0.794	0.781	0.769	0.751	0.734	0.718	0.667
2	0.980	0.961	0.943	0.925	0.909	0.893	0.877	0.870	0.862	0.854	0.839	0.825	0.812	0.798	0.792	0.786	0.773	0.761	0.743	0.727	0.711	0.644
3	0.970	0.951	0.933	0.915	0.899	0.883	0.867	0.860	0.852	0.844	0.829	0.815	0.802	0.788	0.782	0.776	0.763	0.751	0.733	0.717	0.701	0.634
4	0.961	0.943	0.925	0.909	0.893	0.877	0.861	0.854	0.846	0.838	0.823	0.809	0.796	0.782	0.776	0.770	0.757	0.745	0.727	0.711	0.695	0.628
5	0.951	0.933	0.915	0.899	0.883	0.867	0.851	0.844	0.836	0.828	0.813	0.800	0.786	0.772	0.766	0.760	0.747	0.735	0.717	0.701	0.685	0.618
6	0.942	0.925	0.909	0.893	0.877	0.861	0.845	0.838	0.830	0.822	0.807	0.794	0.780	0.766	0.760	0.754	0.741	0.729	0.711	0.695	0.679	0.612
7	0.933	0.915	0.899	0.883	0.867	0.851	0.835	0.828	0.820	0.812	0.797	0.784	0.770	0.756	0.750	0.744	0.731	0.719	0.701	0.685	0.669	0.602
8	0.925	0.909	0.893	0.877	0.861	0.845	0.829	0.822	0.814	0.806	0.791	0.778	0.764	0.750	0.744	0.738	0.725	0.713	0.695	0.679	0.663	0.596
9	0.915	0.899	0.883	0.867	0.851	0.835	0.819	0.812	0.804	0.796	0.781	0.768	0.754	0.740	0.734	0.728	0.715	0.703	0.685	0.669	0.653	0.586
10	0.909	0.893	0.877	0.861	0.845	0.829	0.813	0.806	0.798	0.790	0.775	0.762	0.748	0.734	0.728	0.722	0.709	0.697	0.679	0.663	0.647	0.580
11	0.900	0.883	0.867	0.851	0.835	0.819	0.803	0.796	0.788	0.780	0.765	0.752	0.738	0.724	0.718	0.712	0.699	0.687	0.669	0.653	0.637	0.570
12	0.890	0.873	0.857	0.841	0.825	0.809	0.793	0.786	0.778	0.770	0.755	0.742	0.728	0.714	0.708	0.702	0.689	0.677	0.659	0.643	0.627	0.560
13	0.880	0.863	0.847	0.831	0.815	0.799	0.783	0.776	0.768	0.760	0.745	0.732	0.718	0.704	0.698	0.692	0.679	0.667	0.649	0.633	0.617	0.550
14	0.870	0.853	0.837	0.821	0.805	0.789	0.773	0.766	0.758	0.750	0.735	0.722	0.708	0.694	0.688	0.682	0.669	0.657	0.639	0.623	0.607	0.540
15	0.861	0.843	0.827	0.811	0.795	0.779	0.763	0.756	0.748	0.740	0.725	0.712	0.698	0.684	0.678	0.672	0.659	0.647	0.629	0.613	0.597	0.530
16	0.853	0.835	0.819	0.803	0.787	0.771	0.755	0.748	0.740	0.732	0.717	0.704	0.690	0.676	0.670	0.664	0.651	0.639	0.621	0.605	0.589	0.522
17	0.844	0.826	0.810	0.794	0.778	0.762	0.746	0.739	0.731	0.723	0.707	0.694	0.680	0.666	0.660	0.654	0.641	0.629	0.611	0.595	0.579	0.512
18	0.836	0.818	0.802	0.786	0.770	0.754	0.738	0.731	0.723	0.715	0.699	0.686	0.672	0.658	0.652	0.646	0.633	0.621	0.603	0.587	0.571	0.504
19	0.828	0.810	0.794	0.778	0.762	0.746	0.730	0.723	0.715	0.707	0.691	0.678	0.664	0.650	0.644	0.638	0.625	0.613	0.595	0.579	0.563	0.496
20	0.820	0.802	0.786	0.770	0.754	0.738	0.722	0.715	0.707	0.699	0.683	0.670	0.656	0.642	0.636	0.630	0.617	0.605	0.587	0.571	0.555	0.488
21	0.811	0.793	0.777	0.761	0.745	0.729	0.713	0.706	0.698	0.690	0.674	0.661	0.647	0.633	0.627	0.621	0.608	0.596	0.578	0.562	0.546	0.479
22	0.803	0.785	0.769	0.753	0.737	0.721	0.705	0.698	0.690	0.682	0.666	0.653	0.639	0.625	0.619	0.613	0.600	0.588	0.570	0.554	0.538	0.471
23	0.795	0.777	0.761	0.745	0.729	0.713	0.697	0.690	0.682	0.674	0.658	0.645	0.631	0.617	0.611	0.605	0.592	0.580	0.562	0.546	0.530	0.463
24	0.788	0.769	0.753	0.737	0.721	0.705	0.689	0.682	0.674	0.666	0.650	0.637	0.623	0.609	0.603	0.597	0.584	0.572	0.554	0.538	0.522	0.455
25	0.780	0.761	0.745	0.729	0.713	0.697	0.681	0.674	0.666	0.658	0.642	0.629	0.615	0.601	0.595	0.589	0.576	0.564	0.546	0.530	0.514	0.447
26	0.772	0.753	0.737	0.721	0.705	0.689	0.673	0.666	0.658	0.650	0.634	0.621	0.607	0.593	0.587	0.581	0.568	0.556	0.538	0.522	0.506	0.439
27	0.764	0.745	0.729	0.713	0.697	0.681	0.665	0.658	0.650	0.642	0.626	0.613	0.599	0.585	0.579	0.573	0.560	0.548	0.530	0.514	0.498	0.431
28	0.757	0.737	0.721	0.705	0.689	0.673	0.657	0.650	0.642	0.634	0.618	0.605	0.591	0.577	0.571	0.565	0.552	0.540	0.522	0.506	0.490	0.423
29	0.749	0.729	0.713	0.697	0.681	0.665	0.649	0.642	0.634	0.626	0.610	0.597	0.583	0.569	0.563	0.557	0.544	0.532	0.514	0.498	0.482	0.415
30	0.742	0.722	0.706	0.690	0.674	0.658	0.642	0.634	0.626	0.618	0.602	0.589	0.575	0.561	0.555	0.549	0.536	0.524	0.506	0.490	0.474	0.407
40	0.572	0.451	0.298	0.097	0.046	0.022	0.011	0.005	0.004	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
50	0.608	0.372	0.141	0.054	0.021	0.009	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

APPENDIX B

Table B
PRESENT VALUE OF \$1 RECEIVED ANNUALLY FOR N YEARS

Years (N)	1%	2%	4%	6%	8%	10%	12%	14%	15%	16%	18%	20%	22%	25%	28%	30%	35%	40%	45%	50%
1	0.990	0.980	0.962	0.943	0.926	0.909	0.893	0.877	0.860	0.843	0.827	0.811	0.795	0.779	0.763	0.747	0.731	0.715	0.699	0.683
2	1.970	1.942	1.886	1.831	1.776	1.721	1.666	1.611	1.556	1.501	1.446	1.391	1.336	1.281	1.226	1.171	1.116	1.061	1.006	0.951
3	2.941	2.894	2.775	2.673	2.577	2.482	2.387	2.292	2.237	2.182	2.127	2.072	2.017	1.962	1.907	1.852	1.797	1.742	1.687	1.632
4	3.902	3.838	3.652	3.485	3.332	3.180	3.027	2.874	2.761	2.648	2.535	2.422	2.309	2.196	2.083	1.970	1.857	1.744	1.631	1.518
5	4.853	4.773	4.452	4.212	3.993	3.794	3.605	3.416	3.332	3.248	3.164	3.080	2.996	2.912	2.828	2.744	2.660	2.576	2.492	2.408
6	5.795	5.698	5.242	4.917	4.623	4.358	4.111	3.883	3.784	3.690	3.606	3.522	3.438	3.354	3.270	3.186	3.102	3.018	2.934	2.850
7	6.728	6.623	6.032	5.592	5.275	4.989	4.731	4.493	4.384	4.290	4.206	4.122	4.038	3.954	3.870	3.786	3.702	3.618	3.534	3.450
8	7.652	7.538	6.812	6.263	5.935	5.647	5.389	5.151	5.042	4.948	4.864	4.780	4.696	4.612	4.528	4.444	4.360	4.276	4.192	4.108
9	8.566	8.443	7.582	6.923	6.584	6.295	6.037	5.799	5.690	5.606	5.522	5.438	5.354	5.270	5.186	5.102	5.018	4.934	4.850	4.766
10	9.471	9.339	8.342	7.573	7.233	6.943	6.685	6.447	6.338	6.254	6.170	6.086	6.002	5.918	5.834	5.750	5.666	5.582	5.498	5.414
11	10.368	10.227	9.092	8.212	7.871	7.580	7.321	7.083	6.974	6.890	6.806	6.722	6.638	6.554	6.470	6.386	6.302	6.218	6.134	6.050
12	11.258	11.108	9.922	8.932	8.590	8.298	8.039	7.801	7.692	7.608	7.524	7.440	7.356	7.272	7.188	7.104	7.020	6.936	6.852	6.768
13	12.134	11.974	10.736	9.636	9.293	8.999	8.740	8.502	8.393	8.309	8.225	8.141	8.057	7.973	7.889	7.805	7.721	7.637	7.553	7.469
14	13.006	12.836	11.546	10.346	10.002	9.707	9.448	9.210	9.101	9.017	8.933	8.849	8.765	8.681	8.597	8.513	8.429	8.345	8.261	8.177
15	13.865	13.685	12.352	11.152	10.807	10.511	10.252	10.014	9.905	9.821	9.737	9.653	9.569	9.485	9.401	9.317	9.233	9.149	9.065	8.981
16	14.718	14.528	13.152	11.952	11.606	11.309	11.050	10.812	10.703	10.619	10.535	10.451	10.367	10.283	10.199	10.115	10.031	9.947	9.863	9.779
17	15.562	15.362	13.942	12.742	12.395	12.097	11.838	11.600	11.491	11.407	11.323	11.239	11.155	11.071	10.987	10.903	10.819	10.735	10.651	10.567
18	16.398	16.198	14.732	13.532	13.184	12.886	12.627	12.389	12.280	12.196	12.112	12.028	11.944	11.860	11.776	11.692	11.608	11.524	11.440	11.356
19	17.226	17.026	15.512	14.312	13.963	13.664	13.405	13.167	13.058	12.974	12.890	12.806	12.722	12.638	12.554	12.470	12.386	12.302	12.218	12.134
20	18.046	17.846	16.282	15.082	14.732	14.432	14.173	13.935	13.826	13.742	13.658	13.574	13.490	13.406	13.322	13.238	13.154	13.070	12.986	12.902
21	18.858	18.658	17.052	15.852	15.501	15.201	14.942	14.704	14.595	14.511	14.427	14.343	14.259	14.175	14.091	14.007	13.923	13.839	13.755	13.671
22	19.663	19.463	17.812	16.612	16.260	15.959	15.700	15.462	15.353	15.269	15.185	15.101	15.017	14.933	14.849	14.765	14.681	14.597	14.513	14.429
23	20.460	20.260	18.562	17.362	17.009	16.708	16.449	16.211	16.102	16.018	15.934	15.850	15.766	15.682	15.598	15.514	15.430	15.346	15.262	15.178
24	21.250	21.050	19.302	18.102	17.748	17.446	17.187	16.949	16.840	16.756	16.672	16.588	16.504	16.420	16.336	16.252	16.168	16.084	16.000	15.916
25	22.033	21.833	20.032	18.832	18.477	18.174	17.915	17.677	17.568	17.484	17.400	17.316	17.232	17.148	17.064	16.980	16.896	16.812	16.728	16.644
26	22.816	22.616	20.762	19.562	19.206	18.902	18.643	18.405	18.296	18.212	18.128	18.044	17.960	17.876	17.792	17.708	17.624	17.540	17.456	17.372
27	23.599	23.399	21.492	20.292	19.935	19.630	19.371	19.133	19.024	18.940	18.856	18.772	18.688	18.604	18.520	18.436	18.352	18.268	18.184	18.100
28	24.374	24.174	22.212	21.012	20.654	20.348	20.089	19.851	19.742	19.658	19.574	19.490	19.406	19.322	19.238	19.154	19.070	18.986	18.902	18.818
29	25.149	24.949	22.932	21.732	21.373	21.066	20.806	20.568	20.459	20.375	20.291	20.207	20.123	20.039	19.955	19.871	19.787	19.703	19.619	19.535
30	25.916	25.716	23.642	22.442	22.082	21.774	21.514	21.276	21.167	21.083	21.000	20.916	20.832	20.748	20.664	20.580	20.496	20.412	20.328	20.244
31	26.683	26.483	24.352	23.152	22.791	22.482	22.222	21.984	21.875	21.791	21.707	21.623	21.539	21.455	21.371	21.287	21.203	21.119	21.035	20.951
32	27.449	27.249	25.162	23.962	23.600	23.290	23.030	22.792	22.683	22.600	22.516	22.432	22.348	22.264	22.180	22.096	22.012	21.928	21.844	21.760
33	28.216	28.016	25.872	24.672	24.310	24.000	23.740	23.502	23.393	23.310	23.226	23.142	23.058	22.974	22.890	22.806	22.722	22.638	22.554	22.470
34	28.983	28.783	26.582	25.382	25.020	24.710	24.450	24.212	24.103	24.020	23.936	23.852	23.768	23.684	23.600	23.516	23.432	23.348	23.264	23.180
35	29.750	29.550	27.292	26.092	25.730	25.420	25.160	24.922	24.813	24.730	24.646	24.562	24.478	24.394	24.310	24.226	24.142	24.058	23.974	23.890
36	30.516	30.316	28.002	26.802	26.440	26.130	25.870	25.632	25.523	25.440	25.356	25.272	25.188	25.104	25.020	24.936	24.852	24.768	24.684	24.600
37	31.283	31.083	28.762	27.562	27.200	26.890	26.630	26.392	26.283	26.200	26.116	26.032	25.948	25.864	25.780	25.696	25.612	25.528	25.444	25.360
38	32.050	31.850	29.522	28.322	27.960	27.650	27.390	27.152	27.043	26.960	26.876	26.792	26.708	26.624	26.540	26.456	26.372	26.288	26.204	26.120
39	32.816	32.616	30.282	29.082	28.720	28.410	28.150	27.912	27.803	27.720	27.636	27.552	27.468	27.384	27.300	27.216	27.132	27.048	26.964	26.880
40	33.583	33.383	31.042	29.842	29.480	29.170	28.910	28.672	28.563	28.480	28.396	28.312	28.228	28.144	28.060	27.976	27.892	27.808	27.724	27.640
41	34.350	34.150	31.802	30.602	30.240	29.930	29.670	29.432	29.323	29.240	29.156	29.072	28.988	28.904	28.820	28.736	28.652	28.568	28.484	28.400
42	35.116	34.916	32.562	31.362	31.000	30.690	30.430	30.192	30.083	30.000	29.916	29.832	29.748	29.664	29.580	29.496	29.412	29.328	29.244	29.160
43	35.883	35.683	33.322	32.122	31.760	31.450	31.190	30.952	30.843	30.760	30.676	30.592	30.508	30.424	30.340	30.256	30.172	30.088	30.004	29.920
44	36.650	36.450	34.082	32.882	32.520	32.210	31.950	31.712	31.603	31.520	31.436	31.352	31.268	31.184	31.100	31.016	30.932	30.848	30.764	30.680
45	37.416	37.216	34.842	33.642	33.280	32.970	32.710	32.472	32.363	32.280	32.196	32.112	32.028	31.944	31.860	31.776	31.692	31.608	31.524	31.440
46	38.183	37.983	35.602	34.402	34.040	33.730	33.470	33.232	33.123	33.040	32.956	32.872	32.788	32.704	32.620	32.536	32.452	32.368	32.284	32.200
47	38.950	38.750	36.362	35.162	34.800	34.490	34.230	34.002	33.893	33.810	33.726	33.642	33.558	33.474	33.390	33.306	33.222	33.138	33.054	32.970
48	39.716	39.516	37.122	35.922	35.560	35.250	34.990	34.772	34.663	34.580	34.496	34.412	34.328	34.244	34.160	34.076	33.992	33.908	33.824	33.740
49	40.483	40.283	37.882	36.682	36.320	36.010	35.750	35.532	35.423	35.340	35.256	35.172	35.088	35.004	34.920	34.836	34.752	34.668	34.584	34.500
50	41.250	41.050	38.642	37.442	37.080	36.770	36.510	36.292	36.183	36.100	36.016	35.932	35.848	35.764	35.680	35.596	35.512	35.428	35.344	35.260

BIBLIOGRAPHY

1. Anthony, Robert N. and Reece, James S., Management Accounting Principles. Homewood, Illinois: Richard D. Irwin, Inc., 1975.
2. Bierman, Harold and Dyckman, Thomas R., Managerial Cost Accounting. New York: MacMillan Co., 1971.
3. Bierman, Harold and Smidt, Seymour, The Capital Budgeting Decision. New York: MacMillan Co., 1966.
4. Buttors, Keith J., Fruhan, William E. Jr., and Piper, Thomas R., Case Problems in Finance. 6th ED. Homewood, Illinois: Richard D. Irwin, Inc., 1972.
5. Johnson, Robert W., Capital Budgeting, Belmont, California: Wadsworth Publishing Co., Inc., 1970.